

CLAIMS

1. A treatment method for improving fatigue life, characterized in that, for the portion of metal material for which fatigue may become a problem, after pre-treatment is performed, ultrasonic impact treatment is performed, and thereafter quality assurance test is performed, to thereby improve fatigue life of the metal material.

2. A treatment method for improving fatigue life according to claim 1, wherein, for the portion of metal material to be subjected to the ultrasonic impact treatment and the neighboring portion, after processes such as plastic processing, deformation correction, heat treatment, welding or the like that alter internal stress and surface stress of the metal material is performed in the pre-treatment, ultrasonic impact treatment is performed, and after the ultrasonic impact treatment, no such process that alters internal stress and surface stress of the metal material is performed.

3. A treatment method for improving fatigue life according to claim 1, wherein, in the pre-treatment, for the portion of metal material to be subjected to the ultrasonic impact treatment and the neighboring portion, after processes such as plastic processing, deformation correction, heat treatment, welding or the like that alter internal stress and surface stress of the metal is performed, a non-destructive test and ultrasonic impact treatment are performed, and after the ultrasonic impact treatment, no such process that alters internal stress and surface stress of the metal is performed.

4. A treatment method for improving fatigue life according to claim 1, wherein, in the pre-treatment, for portions for which fatigue life may become a problem, after visual inspection, liquid penetrant examination, magnetic particle examination, eddy current examination or the like is performed, and if a crack is detected, the crack is removed by a grinder, by gouging, or by the

like.

5. A treatment method for improving fatigue life according to claim 4, wherein, in the removal of the crack, if the removal depth is as deep as 5 mm or more, after a build-up welding is performed, the surface is finished flat and smooth with a grinder, and visual inspection, liquid penetrant examination, magnetic particle examination, eddy current examination or the like is performed to confirm that no crack can be detected.

6. A treatment method for improving fatigue life according to claim 1, wherein, in the ultrasonic impact treatment, the treatment is performed on a toe portion, a HAZ portion, and a weld portion of the welding of the metal material, so as to deform the shape such that stress concentration is unlikely to occur, and compressive residual stress is introduced to render minute defects, which may become origins of fatigue crack generation, harmless and to thereby suppress generation of cracks.

7. A treatment method for improving fatigue life according to claim 1, wherein, in the ultrasonic impact treatment, the treatment is performed on a cut section produced by cutting of metal material with a saw, shearing, gas, laser, plasma, or the like, and on its vicinity, so as to deform the shape such that stress concentration is unlikely to occur, and compressive residual stress is introduced so as to render minute defects, and extremely hardened portions which may become an origin of fatigue crack generation, harmless and to thereby suppress generation of cracks.

8. A treatment method for improving fatigue life according to claim 1, wherein, in the ultrasonic impact treatment, compressive residual stress is introduced by impact using the ultrasonic impact treatment on cracks below the detection limit of non-destructive test to thereby stop propagation of the cracks.

9. A treatment method for improving fatigue life according to claim 1, wherein, in the ultrasonic impact treatment, for portions of a structure or structural product in which generation of fatigue cracks may become
5 a problem, by performing two passes or more of ultrasonic impact treatment on the same portion, compressive residual stress is introduced to cracks below the detection limit of non-destructive test to stop development of the cracks more reliably.

10 10. A treatment method for improving fatigue life according to claim 1, wherein, in the quality assurance test, by using form replicating material such as dental shaping agent, or by scanning with a high precision measuring instrument such as a laser displacement meter,
15 the shape of the treated surface after the ultrasonic impact treatment is replicated, to confirm that the radius of curvature of the treated surface is approximately the same as radius R of the tool tip used in the ultrasonic impact treatment and that, compared to
20 the state before treatment, plastic deformation has been produced to a depth of 5 mm or greater, thereby to confirm that shape has been improved in the portion subjected to the treatment and that fatigue life is improved by introduction of compressive residual stress.

25 11. A treatment method for improving fatigue life according to claim 1, wherein, in the quality assurance test, if the ultrasonic impact treatment is performed as a stationary process, the tool tip used in the ultrasonic impact treatment is checked, the output setting of the
30 apparatus is checked, and generation of plastic deformation at the treated portion is visually checked, to confirm that shape has been improved in the portion subjected to the treatment and that fatigue life is improved by introduction of compressive residual stress.

35 12. A treatment method for improving fatigue life according to claim 1, wherein, in the quality assurance test, if it is doubted whether the deformation has been

produced by the ultrasonic impact treatment, in measuring the deformation formed on the metal surface, SUMP method is used to replicate the treated surface and to observe metal microstructure of the topmost surface, and thereby
5 to confirm that the microstructure is finer than the other untreated portion, and hence to determine that the deformation has been formed by the ultrasonic impact treatment.

13. A treatment method for improving fatigue life
10 according to claim 1, wherein, in the quality assurance test, if it is doubted whether the deformation has been produced by the ultrasonic impact treatment, in measuring the deformation formed on the metal surface, the grain size of the treated surface is measured at the topmost
15 surface using an ultrasonic grain size measuring apparatus to thereby determine that the deformation has been formed by the ultrasonic impact treatment.

14. A treatment method for improving fatigue life according to claim 1, wherein, in the quality assurance
20 test, if it is doubted whether the deformation has been produced by the ultrasonic impact treatment, in measuring the deformation formed on the metal surface, a surface roughness meter or a laser displacement meter is used to measure the roughness of the treated surface, and by
25 confirming that the treated surface is smoother than in the other untreated portion in the direction perpendicular to the formed curve with a radius R, determining that the deformation has been formed by the ultrasonic impact treatment.

15. A treatment method for improving fatigue life according to claim 1, wherein, in the quality assurance
30 test, if it is doubted whether the deformation has been produced by the ultrasonic impact treatment, in measuring the deformation formed on the metal surface, hardness of the treated surface is measured by Vickers test or the
35 like to confirm that the surface hardness of the treated surface is higher by not less than 20 % and less than 100

% than other untreated portion and thereby determining that the deformation has been formed by the ultrasonic impact treatment.

5 16. A treatment method for improving fatigue life according to claim 1, wherein, in the quality assurance test, subsequent generation of cracks can be visualized by applying a paint to the portion that has been subjected to the ultrasonic impact treatment and has passed the quality assurance test, so that, when a crack
10 is generated during subsequent usage, micro-capsules contained in the paint film are broken at the crack and a paint of different color oozes out to indicate easily the generation of the crack.

15 17. A metal material that has been treated using a treatment method for improving fatigue life according to any one of claims 1 to 16.